F-832

**INTERNATIONAL PRELIMINARY EXAMINATION REPORT – SUPPLEMENT**

International Reference: PCT/CH02/0678

**Item V**

**Substantiated determination according to Art. 35(2) relative to novelty, inventive activity and commercial applicability; documents and explanations in support of this determination**

Reference is made to the following documents:

D1: EP-A-0 612 603 (HUTCHINSON) August 31, 1994 (1994-08-31)
D2: SU 856 833 A (INST MEK SPLOSHNYKH SRED URAL) August 26, 1981
D3: GB-A-1 171 735 (GLANZSTOFFE AG) November 26, 1969 (1969-11-26)
D4: SU-A-1 445 676 (MO T I PISHCHEVOJ PROMY) December 23, 1988

1. Subject matter of application

The application relates to a device for processing a conveyable material by means of vibratable collision bodies.

2. Prior art

Machines having an outlet section in which moveably mounted partial areas of the channel are coupled with oscillation sources are known from D1 to D4.

3. Object / solution

The object of the invention is to intensify the introduction of oscillations in the fluid.
The object is achieved according to the invention by filling a volumetric section of the channel with vibratable collision bodies.
The features of independent claim 1 differ from D1, which can be regarded as most obvious prior art, with respect to filling with vibratable collision bodies. The features of claim 1 are novel in this regard.
The Documents D1 to D4 cited in the search report only show conventional oscillation sources externally secured to a partial area of the outlet section, but no free collision bodies in the channel itself.

The combination of features is not disclosed in any previously available publications, nor made obvious therein. Therefore, the documents provide no indication of this possibility. As a consequence, the subject matter of the application satisfies the requirements set forth in Art. 33(2) and (3) of the PCT relative to novelty and inventive activity.

4. Dependent claims 2-29

The features in the subject matter of dependent claims 2 to 29 each relate to expedient design advancements. They can be regarded as novel and based upon an inventive activity in conjunction with the back-referenced independent claim.
Therefore, the dependent claims also satisfy the requirements set forth in Art. 33(2) and 33(3) of the PCT.

Industrial applicability
The subject matter of the application satisfies the requirements set forth in Art. 33(4) relative to the industrial applicability of the claimed invention.

5. Comment

The changes (additional features) to claim 1 are permissible, since they were derived from subclaim 26 or arise from the specification.

F-8321

# MACHINE WITH VIBRATABLE SECTION

The present invention relates to a machine for treating or processing a conveyable material, in particular, a flowable or pasty composition or a loose material, the machine having at least one passage section with at least one passage, through which the conveyable material, which is to be treated or processed, can be transported along a conveying direction.

The material is transported and treated or processed in such machines. Viscous or pasty compositions, such as chocolate, dough or thermoplastic or elastomeric materials, are transported, for example, by means of an extruder. The treatment or processing takes place in mixers, rolling mills, mills or extruders, depending on the material. At the same time, the material is sheared and/or stretched and therefore thoroughly mixed. In the case of emulsions (such as chocolate) or suspensions (wet grinding), the emulsified or suspended particles are comminuted. Most often, the objective is to modify the rheological properties of the material more or less permanently by changing, for example, the size distribution of emulsified or suspended particles, the degree of cross-linking of structures or the average length of molecules. Such changes are produced by mechanical, thermal, chemical or enzymatic action.

Much energy and, in some cases, appropriately large machines are required for transporting, treating and processing viscous or pasty compositions and also for transporting loose materials.

The EP 0 612 603 describes a system and a method for facilitating the flow of an elastomeric materials through a nozzle. For this purpose, a nozzle of an extruder and, accordingly, a passage formed in the nozzle, are vibrated by means of

ultrasound, as a result of which the friction between the material and the passage is decreased. The vibration is produced by means of an electric circuit, which applies an electric vibrational signal to a piezoelectric converter. This signal can then be transformed into mechanical vibrations, which are transferred to the passage.

The SU 856 833 A1 and SU 1 445 676 A1 disclose a similar system. Here also, one or more vibration emitters are provided, which are mounted at the inner wall of an extruder housing also in the discharge region of the extruder.

The GB 1,171,735 A1 describes a spin packing, which is disposed upstream from a nozzle plate, with which polymers are spun into filaments. For this purpose, the polymer melt must be pumped through the holes of the nozzle plate. Balls are contained in the spin packing and form a ball bed, which ensures equalization of the melt flow over the whole of the nozzle plate, so that the residence time of the polymer melt in the whole of the spinning head is as uniform as possible over the surface of the nozzle plate and, above all, so that dead regions between the nozzle holes, which are relatively far apart in comparison to their diameter, are avoided.

For all of these known solutions of the state of the art, vibrations for affecting the rheological properties of the fluid are induced only over the surface of a vibrating nozzle or of a different vibrating region in the interior of a housing in a viscous or viscoelastic fluid (suspension, emulsion, melt of a thermoplastic material, elastomer).

The GB 1,171,735 A admittedly mentions two balls in a spin packing. However, these balls form a "ball bed" in the spin packing, which, instead of vibrating, only brings about an equalization of the residence time of the fluid flowing through the ball bed. Every effort is made not to interfere in any way and, especially, and not by vibrations, with the very unstable spinning process.

It is there for an object of the invention to save energy and/or minimize machine size during treating and processing and, above all, during the transport of the viscous or viscoelastic, pasty composition in the machine.

This objective is accomplished owing to the fact that, for the machine of the type named above, the at least one passage section ("vibrochannel", "vibrosection") forms at least one partial region of a channel of the machine and is mounted movably with respect to the channel of the machine, the at least one passage section being coupled with at least one source of vibrations, by means of which it can be caused to vibrate mechanically relative to the channel of machine.

In the case of a further, advantageous embodiment of the inventive machine, the at least one passage section in the channel of the machine is a volume section of the channel, which is filled with vibratable collision bodies. A collision body packing, in which the collision bodies are packed more or less tightly, is formed. The source of vibrations, coupled with the collision-body packing, transmits impacts over the wall of the packing to the collision bodies in the packing, causing them to vibrate. The material, transported in the passage section between the collision bodies, is treated by the movement of the collision bodies essentially in two ways. On the one hand, the impacts between the collision bodies disperse or deagglomerate emulsified or suspended particles of the material, which happen to be between the collision bodies impacting on one another. On the other, relative movements of adjacent collision bodies, which do not impact on one another, lead to a shear gradient and, with that, to a shearing and/or extension of the material, as a result of which the viscosity is decreased.

Advisably, the collision bodies form the tightest possible packing with cavities between mutually contacting collision bodies, the latter having, in particular, different sizes and/or different shapes. For such a development, there are, on the one

hand, many collision bodies in the packing and this leads to a large number of impacts. On the other hand, the average distances between adjacent collision bodies are small, so that, at a given impact energy, there is a large shear gradient and extension gradient.

The collision bodies may, if necessary, have at least one of the following shapes: spherical, polyhedral, rod-shaped and, in particular, a cylindrical shape or the shape of a prism.

For the spherical shape, very high impact forces, acting at points, are obtained. By means of these impact forces, even very stable agglomerates can be broken up, however, with a very low probability of striking such an agglomerate. The polyhedral shape makes relatively weak two-dimensional or edge-like impact forces possible. However, the probability of striking an agglomerate is much higher here than in the case of the spherical shape. Moreover, the shearing action may be expected to be higher here than in the case of the spherical shape. For rod-shaped collision bodies, vibrations with a preferential direction can be induced in the collision body packing. Accordingly, the rods may be arranged parallel to one another in the packing and the impact excitation may be such that predominantly a back and forth movement of the rods takes place in the direction of the rods. In this way, the shearing action between the rods dominates over the impact action between the rods. If the passage section and the rods are arranged vertically, the prismatic shape is preferred. On the other hand, if passage section is arranged horizontally, the cylindrical shape is preferred.

Preferably, at least a portion of the collision body consists of an electrically conducting material and the source of the vibrations is a source of electromagnetic vibrations, the electrically conductive collision bodies being excited to carry out mechanical vibrations and/or movements by the electromagnetic AC

FIELDS produced. This embodiment enables the source of vibration to be coupled to the collision bodies inductively and contactlessly in a particularly elegant manner.

In addition to the mechanical, thermal, chemical and enzymatic effects on the material cited, which lead predominantly to permanent changes in the material, the inventive machine also enables the material to be acted upon during its transport through the passage section, which occupies at least a portion of the machine. The material, transported through the passage, is also caused to vibrate by the passage section of the machine, which has been caused to vibrate mechanically. The rheological properties of the material are changed by these vibrations, at least for the duration of the mechanical vibrations.

For example, the vibration of the material, transported through and processed by the machine, can reduce the effective ("apparent") viscosity during the vibrating, so that less conveying or pumping power is required. On the other hand, the vibrating of the material can also contribute to the deagglomerization of particles emulsified or suspended in the material. This effect takes place at least during the vibration and may even last after the vibration.

Preferably, the at least one passage section is mounted elastically with respect to the channel of the machine. This enables the whole of the passage section to vibrate relative to the rest of the channel of the machine. If the mass of the vibratable passage section is only a fraction of the mass of the remaining machine parts, which are connected with one another rigidly, then the amplitude of the vibrations of the vibrating passage section is correspondingly greater by a multiple than the amplitude of vibration of the machine as a whole, including the housing.

The machine may, for example, be an extruder and the at least one passage section may be a nozzle, especially an extrusion nozzle of the extruder. The

vibrating nozzle then also contributes to affecting the rheological properties of the materials and reducing the resistance of the nozzle.

The machine may also be an extruder and at least one passage section a melt filter of the extruder. The vibration of the melt filter then ensures that the latter does not become blocked.

In a further special case, the machine is a die casting machine and the at least one passage section is a conditioning cell of the die casting machine. The pointwise crystallization within the melt, which is to be cast, can be affected by vibrating the conditioning cell (concentration and/or size distribution of the crystalline nuclei and/or the crystallites).

Further advantages, distinguishing features and application possibilities of the invention arise out of the description, which now follows, of examples of the invention by means of the drawing, the examples not limiting the invention.

## Claims

1. Machine for treating or processing conveyable materials, in particular, a flowable or pasty composition or a loose material, the machine having at least one passage section (2; 21; 47, 48) with at least one passage (2a; 21a; 27, 48), through which the conveyable material (M), which is to be treated or processed, can be transported in a conveying direction (F), characterized in that the at least one passage section (2; 21; 47, 48) forms at least one partial region of a channel (1) of the machine and is mounted movably relative to the channel (1) of the machine, the at least one passage section (2; 21; 47, 48) being coupled with at least one source (6, 7, 8, 9) of vibrations, by means of which the passage section (2; 21; 47, 48) can be induced to vibrate mechanically relative to the channel (1) of the machine, characterized in that the at least one passage section (47, 48) in the channel (1) of the machine is a volume section of the channel (1), which is filled with collision bodies (41, 42), which can vibrate.

2. The machine of claim 1, characterized in that the collision bodies (41, 42) form the tightest possible packing (47, 48) with spaces between mutually contacting collision bodies.

3. The machine of claims 1 or 2, characterized in that the collision bodies (41, 42) have different sizes and/or different shapes.

4. The machine of claims 1 to 3, characterized in that the collision bodies (41, 42) have at least one of the following shapes: spherical, polyhedral, rod-shaped and, in particular, a cylindrical shape or the shape of a prism.

5. The machine of one of the claims 1 to 4, characterized in that at least a portion of the collision bodies (41, 42) consists of an electrically conducting material and the source (6, 7, 8, 9) of the vibration is a source of electromagnetic

vibrations, the electrically conducted collision bodies being induced to vibrate mechanically and/or excited to move by the electromagnetic AC fields produced.

6. The machine of one of the claims 1 to 5, characterized in that the at least one passage section (2; 21; 47, 48) is mounted by elastic means (4) relative to the channel of the machine.

7. The machine of one of the preceding claims, characterized in that damping means are disposed between the at least one passage section (2; 21; 47, 48) and the channel (1) of the machine, the conveyable material, in particular, functioning as the damping means.

8. The machine of one of the preceding claims, characterized in that the at least one passage section (2; 21; 47, 48) and the channel (1) of the machine are uncoupled vibrationally.

9. The machine of one of the preceding claims, characterized in that the at least one passage section (2; 21; 47, 48) can be induced to vibrate by the at least one source (6, 7, 8, 9), the vibrations having an tangential and/or a normal component (T, N) with respect to the inner surface (5) of the at least one passage (2a; 21a; 47, 48) facing the conveyable material (M).

10. The machine of one of the preceding claims, characterized in that several passage sections (2; 21; 47, 48) are disposed consecutively in at least one partial region of the channel (1) of the machine along the conveying direction (F) of the channel.

11. The machine of claim 10, characterized in that at least some of the several consecutive passage sections (2; 47, 48) are disposed at a distance from one another in the conveying direction (F).

12. The machine of claims 10 or 11, characterized in that the several passage sections are identical to one another.

13. The machine of claims 10 or 11, characterized in that at least some of the several passage sections (47, 48) are different from one another.

14. The machine of one of the claims 10 to 13, characterized in that several passage sections can be induced to vibrate identically with one another.

15. The machine of one of the claims 10 to 13, characterized in that at least some or several of the passage sections (2; 47, 48) can be induced to vibrate different from one another.

16. The machine of one of the preceding claims, characterized in that the at least one source (6, 7, 8, 9) of mechanical vibrations is a vibrator and the mechanical vibrations are damped, forced vibrations of the at least one passage section (2; 21; 47, 48).

17. The machine of one of the preceding claims, characterized in that the at least source (6, 7, 8, 9) of mechanical vibrations is an impact device and the mechanical vibrations are damped impact excitations of the at least one passage section (2; 21; 47, 48).

18. The machine of claims 16 or 17, characterized in that it has several sources (6, 7, 8, 9) of mechanical vibrations.

19. The machine of one the claims 16 to 18, characterized in that the at least one source (6, 7, 8, 9) of mechanical vibrations can be selected independently of the operating state of the machine.

20. The machine of claims 18 or 19, characterized in that the several sources (6, 7, 8, 9) of mechanical vibrations can be selected separately from one another.

21. The machine of one of the preceding claims, characterized in that at least a first device (10) for determining the rheological properties of the conveyable material is disposed downstream from the respective passage section (2; 21; 47, 48) for generating first signals at a first signal output (11), which characterize the physical, chemical and especially rheological properties of the material (M) downstream from the passage section (2; 21; 47, 48).

22. The machine of one of the preceding claims, characterized in that at least a second device (12) for detecting the rheological properties of the conveyable material (M) is disposed upstream from the respective passage section (2; 21; 47, 48) for producing second signals at a second signal output (13), which characterize the physical, chemical and especially rheological properties of the material (M) upstream from the passage section (2; 21; 47, 48).

23. The machine of one of the claims 21 or 22, characterized in that the signals of the first and/or the second signal output (11, 13) are compared with respective reference signals, which characterize particular rheological properties, there being, depending on the result of the comparison of the signals within a control circuit, feedback for selecting the at least one source (6, 7, 8, 9) of mechanical vibrations.

24. The machine of one of the claims 21, 22 or 23, characterized in that the signals of the first and second signal outputs (11, 13) are compared with one another, there being, depending on the result of the comparison of the signals within a control circuit, feedback for selecting the at least one source (6, 7, 8, 9) of mechanical vibrations.

25. The machine of one of the preceding claims, characterized in that the channel (1) of the machine and the at least one passage (2a; 21a; 47, 48) of the passage section (2; 21; 47, 48) extend vertically.

26. The machine of one of the preceding claims, characterized in that the channel (1) of the machine and the at least one passage (2a; 21a; 47, 48) of the passage section (2; 21; 47, 48) extend horizontally.

27. The machine of one of the preceding claims, characterized in that the machine is an extruder (20) and the at least one passage section (2) is a nozzle, especially an extrusion nozzle.

28. The machine of one of the preceding claims, characterized in that the machine is an extruder (20) and the at least one passage section (2) is a melt filter (21) of the extruder.

29. The machine of one of the claims 1 to 28, characterized in that the machine is a die casting machine (20) and the at least one passage section (2) is a conditioning cell of the die casting machine.